DRAFT - RSVP Review Status Sheet - DRAFT
Due in RSVP Project Office on January 14, 2005
[Please fill in all items in red type]

WBS No. 1.2.1 Title: "Vacuum System" **Date 01/09/05**

Preparer/Manager: "Ralph Brown" **Current Cost Est. (FY05 $M) = 10.74**
Assigned Contingency % = 68.7%

Cost Elements (FY05$M): Matls. = 3.89; Effort = 2.48; Ohd. = xx.x; Conting. = 4.37; Total = 10.74

WBS Dictionary Definition: The KOPIO Detector decay volume and the Neutral Beam path upstream to the spoiler must be at high vacuum (10^{-7} Torr) in order to suppress background from neutron and K^0 interactions with residual gas. The upstream vacuum vessel and entering/exiting beam pipes must present on average 5% of a radiation length of low-Z material. The scope of this subsystem includes the engineering, design, fabrication, procurement and delivery to BNL of all hardware associated with the detector decay volume. This includes the upstream vacuum vessel and entering/exiting beam pipes, vacuum transitions, D4 vacuum box, downstream vacuum vessel, vacuum pumping stations and management activities. Although the neutral beam will be evacuated as part of the detector decay volume, all hardware for this area is part of the neutral beam subsystem.

Technical Level of Confidence: (choose one)	*Prototype* Demonstrated	__	*Elements* Built & Tested	__
	Similar *system* exists	__	Similar *technology* works	__
	Novel system concept	_X	No candidate concept yet	__
	Other (Comment)			

Basis of the Cost Estimate:	Commercial product	36%	Engineered design	0%
(by percentage of total cost;	Engineered conceptual	64%	Scientist conceptual	0%
sum of fractions a-f = 100%)	Guess	0%	Other (specify)	0%

Status of Hardware/Software Development: We are in an R&D prototype fabrication phase with a Russian Aerospace firm to produce and pressure test (5) 1/5 scale composite upstream vacuum vessel and entering/exiting beam pipes to verify material technology and analytical models. IHEP collaborators are working on vessel engineering analysis and monitoring the Russian vendor. We are in contact with interested US vendor who has submitted a draft design/fabrication proposal for a composite upstream vacuum vessel. A recent hire of a consultant engineer at BNL is analyzing various vessel geometries and materials for the upstream vacuum vessel and entering/exiting beam pipes.

Issues (funding, collaborator shortage, engineering help, etc.): This subsystem needs a Subsystem Manager and Project Engineer to plan and coordinate a critical design effort for the detector decay volume hardware. Funding is needed to hire appropriate resources to begin engineering R&D effort on the many technical challenges. The upstream vacuum vessel (3m Ø x 4m lg. x thin wall) offers the greatest technical design risk due to buckling instability of the geometry. The entering/exiting beam pipes with wide aspect ratio requires reinforced structural ribs of low-Z material and must accommodate interlaced detector elements and pump-out ports. The CPV detector located in the upstream vacuum vessel must be isolated from the high vacuum decay region by a thin vacuum membrane. All of these efforts will require extensive design, analysis, prototyping, and testing to develop a workable solution.

RSVP Review Status Sheet

Due in RSVP Project Office on January 14, 2005

KOPIO Construction Project

WBS No. 1.2.2 **Title: "Preradiator"** **Date 01/03/05**

Preparer/Manager: Toshio Numao **Current Cost Est. (FY05 \$M) = 30.9**

Assigned Contingency % = 17%

Cost Elements (FY05\$M): Matls. = 15.91; Effort = 10.45; Ohd. = xx.x; Conting. = 4.49; Total = 30.9

WBS Dictionary Definition: The Preradiator consists of 32 modules, each containing eight layers of dual coordinate drift chambers and nine layers of scintillator, with all necessary electronics for read out and data transmission. The effort is distributed between Chamber System (1.2.2.1), scintillator system (1.2.2.2), electronics (1.2.2.3), mechanics (1.2.2.4) and the photon veto system (1.2.2.5), and the effort necessary to design, prototype, fabricate, install, and commission the Preradiator system. This WBS is a summary level. Detail description and cost estimation are completed at lower levels

Technical Level of Confidence:	*Prototype* Demonstrated	_X_	*Elements* Built & Tested	__
(choose one)	Similar *system* exists	__	Similar *technology* works	__
	Novel system concept	__	No candidate concept yet	__
	Other (Comment)			

Basis of the Cost Estimate:	Commercial product	34.3%	Engineered design	0%
(by percentage of total cost;	Engineered conceptual	24.3%	Scientist conceptual	41.4%
sum of fractions a-f = 100%)	Guess	0%	Other (specify)	0%

Status of Hardware/Software Development: The basic performances of the present design such as resolutions have extensively been tested with prototypes and proven to be adequate. Construction technique has been developed with several prototypes. A full scale module will be built by the middle of this year, and in 2006 we will start construction of the preradiator modules; the first module (also considered to be the second prototype) may take a half year for establishing the procedures and training the workers.

Issues (funding, collaborator shortage, engineering help, etc.): We have not identified the institute that builds external photon veto system although the design is identical to that of the calorimeter system and the cost has been included in the estimates. The installation scheme of the preradiator system has not been finalized yet.

DRAFT - RSVP Review Status Sheet - DRAFT

Due in RSVP Project Office on January 14, 2005

WBS No. 1.2.3 Title: "Calorimeter System" **Date 01/03/05**

Preparer/Manager: "Vladimir Issakov" **Current Cost Est. (FY05 $M) = 9.73**
Assigned Contingency %= 23.7%

Cost Elements (FY05$M): Matls. = 4.48; Effort = 3.39; Ohd. = xx.x; Conting. = 1.86; Total = 9.73

WBS Dictionary Definition: Purpose of Photon Calorimeter is an energy and timing measurement of the decay photons with precision of ~3.5%/√E(GeV) and ~100(psec)/√E(GeV), respectively, and vetoing of background with efficiency better than 10^{-4}. Calorimeter System includes: Mockup of Calorimeter System - the complete-equipped prototype of Calorimeter system (16×8 modules), to study the performance parameters of the Preradiator/Calorimeter systems and to develop DAQ, Front-End-Electronic, the pattern recognition algorithms; Photon Calorimeter itself (2740 APD-instrumented modules, Calorimeter Mechanics & Cooling-system); Calorimeter HV-system; Calorimeter "cosmic-ray" Calibration-system, Calorimeter Monitoring-system and Calorimeter Readout-system.

Technical Level of Confidence: (choose one)	*Prototype* Demonstrated	√	*Elements* Built & Tested	__
	Similar *system* exists	__	Similar *technology* works	__
	Novel system concept	__	No candidate concept yet	__
	Other (Comment)			

Basis of the Cost Estimate:	Commercial product	10%	Engineered design	60%
(by percentage of total cost;	Engineered conceptual	20%	Scientist conceptual	10%
sum of fractions a-f = 100%)	Guess	0%	Other (specify)	0%

Status of Hardware/Software Development:
Prototype for a KOPIO Shashlyk calorimeter with energy resolution of 3%/√E(GeV), time resolution of 90(psec)/√E(GeV) and the photon detection inefficiency less than 5×10^{-5} has been constructed and experimentally tested. ***The tested parameters of Calorimeter prototype well meet the design goals of the experiment.*** Prototype of the readout chain has been modeled, tested and fits well in the overall KOPIO readout scheme. The high-voltage, monitoring and calibration systems have been also designed, based on existing technology. Preliminary prototypes of these systems have been tested and their parameters will well meet the required precision and stability necessary to maintain the energy resolution of Calorimeter. The mechanical issues in mounting a large calorimeter have been addressed and solved in existing detectors. To optimize the Calorimeter module design, the Monte-Carlo simulation model of the Shashlyk module response to incident particles was developed. It includes the effects of shower evolution, light collection in scintillator tiles and light transmission in WLS fibers, response of the photo-detector and noise of all electronic chain. This model describes very well the experimental data.
The engineering design of Shashlyk calorimeter module is done and a pre-production line for fabrication of a pilot batch of the KOPIO Photon Calorimeter modules is ready to start fabrication of Mockup of Calorimeter System.
All of that give us confidence in our cost and manpower requirement estimates.
Issues (funding, collaborator shortage, engineering help, etc.):
To finalize a conceptual mechanical design of whole Calorimeter System we need final solution about design of Vacuum System.

RSVP Review Status Sheet

Due in RSVP Project Office on January 14, 2005

KOPIO Detector Construction Project

WBS No. 1.2.4 Title: "Charged Particle Veto" **Date 01/11/05**

Preparer/Manager: "Andries van der Schaaf" **Current Cost Est. (FY05 $M) = 5.70**
Assigned Contingency % = 37.6%

Cost Elements (FY05$M): Matls. = 2.53; Effort = 1.61; Ohd. = ee.f; Conting. = 1.56; Total = 5.7

WBS Dictionary Definition:
The Charged Particle Veto System (CPV) has the purpose to recognize K decays with two or more charged particles in the final state which otherwise mimic a signal event. The system contains three components (a fourth component is integrated into the photon veto system inside sweeping magnet D4) situated inside the decay tank and downstream beam pipe:

1) **The Barrel CPV consists of plastic scintillator modules surrounding the decay region with the exception of the areas where the beam crosses.**
2) **The Beam Chamber is a 5-plane low-pressure MWPC covering the downstream hole in the Barrel CPV.**
3) **The Downstream CPV consists of plastic scintillator modules lining the beam pipe in the region between Beam Chamber and D4.**

In the case of 2) and 3) it is the combined detection efficiency that has to meet the requirements.

Technical Level of Confidence: *Prototype* Demonstrated

Basis of the Cost Estimate:	Commercial product	75%	Engineered design	0%
(by percentage of total cost;	Engineered conceptual	15%	Scientist conceptual	10%
sum of fractions a-f = 100%)				

Status of Hardware/Software Development:
1) Prototype built and tested
2) Test chamber built and partially tested
3) Concept defined, to be confirmed by R&D

Issues (funding, collaborator shortage, engineering help, etc.):
- Design linked with decay tank
- ~50% shortage of manpower (mainly physicists)
- Practically no exterior funding for hardware

RSVP Review Status Sheet
Due in RSVP Project Office on January 14, 2005

WBS No. 1.2.5 Title: "Photon Veto" **Date 01/14/05**

Preparer/Manager: "Oleg Mineev" **Current Cost Est. (FY05 $M) = 11.71**
Assigned Contingency % = 35%

Cost Elements (FY05$M): Matls. = 5.43; Effort = 3.25; Ohd. = ee.f; Conting. = 3.02; Total = 11.71

WBS Dictionary Definition: The Photon Veto system is comprised of lead-scintillator detectors read-out with wave-shifting fibers and photomultiplier tubes. It is designed to detect and veto photons from decays other than the searched mode. These detectors are located near the vacuum decay volume. There are 4 major subsystems described under this heading. They are: 1- the Upstream Photon Veto (1.2.5.1). The detector forms a wall upstream of the decay volume; 2- the Barrel Photon Veto (1.2.5.2). The detector forms a cylinder that surrounds the decay volume. It is located downstream of the Upstream Photon Veto, but upstream of the preradiator system; 3- the Magnet Photon Veto (1.2.5.3). The detector lines the sweeping magnet which is just downstream of the calorimeter system; 4- the Downstream Photon Veto (1.2.5.4). The detector lines the vacuum region downstream of the sweeping magnet.

Technical Level of Confidence:	*Prototype* Demonstrated	**yes**	*Elements* Built & Tested	__
(choose one)	Similar *system* exists	__	Similar *technology* works	__
	Novel system concept	__	No candidate concept yet	__

Basis of the Cost Estimate:	Commercial product	22 %	Engineered design	8 %
(by percentage of total cost;	Engineered conceptual	35 %	Scientist conceptual	20 %
sum of fractions a-f = 100%)	Guess	15 %	Other (specify)	0 %

Status of Hardware/Software Development: Conceptual design of all detectors has been worked out. R&D and GEANT simulation show performance of detectors sufficient to meet their specified tasks. A few prototype modules were manufactured and tested. Developed technology demonstrated no large problems to create the detectors. Current status is preparation for mass-production. The total detector size is fixed. GEANT simulation is under way to optimize the required performance before mass-production begins. Mechanical design for the detector support begins. Readout instrumentation and front-end electronics for photon veto detectors are unified with the calorimeter ones except photodetectors. Instrumentation and front-end electronics are in engineering design. GEANT models for detectors have been done and used to investigate the physics events reconstruction. Study of algorithms to reconstruct the digitized pulse shape begins.

Issues : Magnet Photon Veto is installed inside the D4 magnet which already exists. Engineering help is required to incorporate the detector in the magnet. Some R&D is planned for Magnet Photon Veto to make a final design of the light readout with spliced WLS and clear fibers. Upstream Photon Veto and Downstream Photon Veto final designs depend on the vacuum pipe development. Besides DS Veto is located inside the vacuum pipe so the optical readout through the pipe walls must be engineered. Mechanical support design for Barrel Veto poses a conflict between the requirement to keep all gaps between the modules as low as possible and achievable in large splitted setup tolerances. BV mechanics is designed taking into account the assembling issues as well as the shashlyk module mechanical parameters. Front-end electronics (waveform digitizers) is a new development which will require a new approach to analyze the signals.

DRAFT - RSVP Review Status Sheet - DRAFT

Due in RSVP Project Office on January 14, 2005

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WBS No. 1.2.6 Title: "Catcher system" **Date 01/14/05**

Preparer/Manager: "Tadashi Nomura / Noboru Sasao"

Current Cost Est. (FY05 $M) = 3.38
Assigned Contingency % = 11.0%

Cost Elements (FY05$M): Matls. = 2.96; Effort = 0.09; Ohd. = 0.00; Conting. = 0.33; Total = 3.38

WBS Dictionary Definition:

"Photon detectors to catch photons coming along the neutral beam line.
The aerogel catcher is placed in the beam and the guard counter covers the halo region."

Technical Level of Confidence: (choose one)

Prototype Demonstrated	X	*Elements* Built & Tested	__
Similar *system* exists	__	Similar *technology* works	__
Novel system concept	__	No candidate concept yet	__
Other (Comment)			

Basis of the Cost Estimate: (by percentage of total cost; sum of fractions a-f = 100%)

Commercial product	71.2%	Engineered design	0%
Engineered conceptual	12.4%	Scientist conceptual	10.1%
Guess	6.3%	Other (specify)	0%

Status of Hardware/Software Development:

The proof of principle has been done by two generations of prototypes.
(Our simulation well reproduces the results.)
Quality checking systems for elements (aerogel, PMT…) have been developed.
Full size prototype module is now being designed.

Issues (funding, collaborator shortage, engineering help, etc.):

No technical difficulty
Support by Japan-US cooperative program expected

WBS No. 1.2.7 Title: "Trigger" **Date 01/10/05**

Preparer/Manager: "Nello Nappi"

Current Cost Est. (FY05 $M) = 5.93
Assigned Contingency % = 40.8%

Cost Elements (FY05$M): Matls. = 2.07; Effort = 2.14; Ohd. = ee.f; Conting. = 1.72; Total = 5.93

WBS Dictionary Definition: Development of the algorithms and of the electronics for the on line selection of events. The system includes dedicated digitizers of preradiator, calorimeter and veto scintillator signals, a pipelined logic system requiring design and construction of three types of collector boards, three types of logic modules, a trigger supervisor system and the RF synchronized clock system.

Technical Level of Confidence:	*Prototype* Demonstrated	__	*Elements* Built & Tested	__
(choose one)	Similar *system* exists	__	Similar *technology* works	_X_
	Novel system concept	__	No candidate concept yet	__
	Other (Comment)			

Basis of the Cost Estimate:	Commercial product	8%	Engineered design	--%
(by percentage of total cost;	Engineered conceptual	14%	Scientist conceptual	78%
sum of fractions a-f = 100%)	Guess	--%	Other (specify)	--%

Status of Hardware/Software Development: pre-conceptual

Issues (funding, collaborator shortage, engineering help, etc.): None of the groups within the collaboration can provide yet significant levels of involvement in the trigger design and development. In particular at present no engineering support is available. The project will require at least 5FTE physicists and 5 FTE engineers from now to the time of completion. In order to make it viable, new collaborators have to be found or new manpower resources have to become available for some of the existing groups.

DRAFT - RSVP Review Status Sheet - DRAFT

Due in RSVP Project Office on January 14, 2005

WBS No. 1.2.8 Title: "DAQ" **Date 01/03/05**

Preparer/Manager: "George Redlinger" **Current Cost Est. (FY05 $M) = 5.72**
Assigned Contingency % = 25.4%

Cost Elements (FY05$M): Matls. = 2.53; Effort = 2.03; Ohd. = ee.f; Conting. = 1.16; Total = 5.72

WBS Dictionary Definition:
DAQ refers to the transfer of digitized data from the front-end electronics after a Level 1 trigger accept. DAQ consists of three main components: Event Builder, Level 3 Trigger and Online Software. The Event Builder receives digitized data from the front-end electronics and combines the event fragments into complete events. The Event Builder is based on a farm of computers communicating with the front-end electronics through a network switch. The Level 3 trigger receives complete events from the Event Builder, applies additional event filtering criteria and sends the surviving events to permanent storage; it can also perform detector calibrations and monitoring in real-time with access to a much larger data set than would be available from permanent storage. The Level 3 trigger is based on a farm of computers communicating with the Event Builder computers through Gigabit ethernet. Online Software is the glue that holds the DAQ system together. It includes a run controller, a user interface, an event logger, interfaces to the Event Builder, to the L1/L3 trigger systems, to the slow control and to online monitoring/calibration tasks.

Technical Level of Confidence:	*Prototype* Demonstrated	__	*Elements* Built & Tested	__
(choose one)	Similar *system* exists	__	Similar *technology* works	X
	Novel system concept	__	No candidate concept yet	__
	Other (Comment)			

Basis of the Cost Estimate:	Commercial product	44%	Engineered design	0%
(by percentage of total cost;	Engineered conceptual	0%	Scientist conceptual	56%
sum of fractions a-f = 100%)	Guess	0%	Other (specify)	0%

Status of Hardware/Software Development:
The hardware for the Event Builder and part of the Level 3 Trigger is based on commercial computing and networking hardware. There is a possibility for a custom hardware component to the Level 3 Trigger; only a scientist's concept exists for this. The software to control the Event Builder, Level 3 Trigger and the overall data flow will be based heavily on the CMS XDAQ project. Apart from examining the suitability of XDAQ software for KOPIO, no work has been done on customizing it for the experiment. Software for the Level 3 trigger algorithms will need to be written; only a vague idea of the effective algorithms exists at the moment.

Issues (funding, collaborator shortage, engineering help, etc.):

Event Builder:
1. More detailed estimate of data rates from simulation
2. Measurement of real-time performance of small-scale prototype

Level 3 trigger:

1. Development of trigger algorithms and a coherent picture of DAQ and trigger across all levels
2. Measurements of real-time performance on a small-scale prototype. Requires substantial development in the area of offline analysis.
3. Need for custom hardware for Level 3 depends on the as yet unknown performance of the software trigger. No design, no engineer working on this (yet); some prospects of collaboration with BNL Instrumentation.

Manpower:

We need more manpower. Currently we have only one physicist and one electronics technician. Ultimately we need a core of at least 3 physicists and one software engineer to implement the Event Builder, Level 3 Trigger and Online Software. For the Level 3 Trigger algorithm development, we rely heavily on the existence of manpower to develop the offline analysis tools (costed under Offline Software). For the custom Level 3 hardware, we need in addition one electronics engineer and one physicist.

DRAFT - RSVP Review Status Sheet - DRAFT
Due in RSVP Project Office on January 14, 2005

WBS No. 1.2.9 Title: "Offline Computing" **Date 01/12/05**

Preparer/Manager: "Renee Poutissou" **Current Cost Est. (FY05 $M) = 2.92**
Assigned Contingency % = 8.5%

Cost Elements (FY05$M): Matls. = 1.1; Effort = 1.6; Ohd. = ; Conting. = .23; Total = 2.92

WBS Dictionary Definition: Offline computing includes both hardware and software needed to process all aspects of the data collected and to simulate the detector performance.
The hardware consists of a compute farm for data reduction and analysis and of several individual workstations. The major software components are simulations, reconstruction, analysis and tools.

Technical Level of Confidence:	*Prototype* Demonstrated	__	*Elements* Built & Tested	__
(choose one)	Similar *system* exists	_X_	Similar *technology* works	__
	Novel system concept	__	No candidate concept yet	__
	Other (Comment)			

Basis of the Cost Estimate:	Commercial product	50%	Engineered design	b%
(by percentage of total cost;	Engineered conceptual	c%	Scientist conceptual	50%
sum of fractions a-f = 100%)	Guess	e%	Other (specify)	f%

Status of Hardware/Software Development: Most hardware components are not needed for the first couple of years since we are using computing resources at remote locations.
In the software area, work is proceeding almost exclusively in the simulations area at the moment. Now that the simulation review is over, it is expected to have some manpower for the reconstruction topic. Investigating the GLAST software as a potential starting point.

Issues (funding, collaborator shortage, engineering help, etc.): - collaborator representative of each subsystem needed to participate in overall software design and development

DRAFT - RSVP Review Status Sheet - DRAFT

Due in RSVP Project Office on January 14, 2005

[Please fill in all items in red type]

WBS No. 1.2.10 Title: "Detector Systems" **Date 01/03/05**

Preparer/Manager: "Ralph Brown" **Current Cost Est. (FY05 $M) = 11.69**
Assigned Contingency % = 31.7%

Cost Elements (FY05$M): Matls. = 3.26; Effort = 5.61; Ohd. = ee.f; Conting. = 2.82; Total = 11.69

WBS Dictionary Definition: The KOPIO Detector, large in size and scope, offers as a project many technical challenges in subsystem design, fabrication, installation, testing and commissioning. The overall detector design, utility requirements, installation, testing and commissioning efforts requires managerial control and oversight to assist individual subsystems in their construction efforts. These efforts also include KOPIO Project interface and interaction with the Collider-Accelerator (C-A) project personnel to insure that beam transport and detector meet the physics operational goals as specified in the baseline. The elements of this subsystem establish the KOPIO project management controls for detector integration, installation, conventional systems, testing and commissioning. It includes the cost and schedule of all materials and labor required to accomplish this effort.

Technical Level of Confidence:	*Prototype* Demonstrated	__	*Elements* Built & Tested	__
(choose one)	Similar *system* exists	_X	Similar *technology* works	__
	Novel system concept	__	No candidate concept yet	__
	Other (Comment)			

Basis of the Cost Estimate:	Commercial product	0%	Engineered design	0%
(by percentage of total cost;	Engineered conceptual	100%	Scientist conceptual	0%
sum of fractions a-f = 100%)	Guess	0%	Other (specify)	0%

Status of Hardware/Software Development: Conceptual installation plan has been developed and work with individual KOPIO subsystems to refine plan is ongoing. Resource loaded schedule for Detector Systems is an engineering estimate based on direct experience with similar large detector construction projects (STAR/RHIC).

Issues (funding, collaborator shortage, engineering help, etc.): Continued effort in support of this subsystem requires funding for engineering and design resources. Recent RIF at BNL and loss of engineering and technical labor force in the region is an issue.

RSVP Review Status Sheet

Due in RSVP Project Office on January 14, 2005

KOPIO Detector Project

WBS No. 1.2.11 Title: Project Services **Date 01/03/05**

Preparer/Manager: Steve Kane **Current Cost Est. (FY05 $M) =8.1**
Assigned Contingency % = 11.0%

Cost Elements (FY05$M): Matls. = .80; Effort = 3.5; Ohd. = 3.0; Conting. = .8; Total = 8.1

WBS Dictionary Definition: This is a Level-of-Effort task for management of the KOPIO Detector Construction Project. It comprises an Administrative function and a Technical function. The Administrative function comprises a full-time Project Manager and secretary, and a half-time budget/schedule person. Material estimates cover travel, reviews, supplies, and space and communications charges at BNL. The Technical function comprises a Chief Engineer, a FEE Coordinator, and AGS Modifications and AGS Beams/Experimental Area.

Technical Level of Confidence:	*Prototype* Demonstrated	__	*Elements* Built & Tested	__
(choose one)	Similar *system* exists	__	Similar *technology* works	__
	Novel system concept	__	No candidate concept yet	__
	Other (Comment)			

Basis of the Cost Estimate:	Commercial product	0%	Engineered design	0%
(by percentage of total cost;	Engineered conceptual	0%	Scientist conceptual	0%
sum of fractions a-f = 100%)	Guess	0%	Other (specify)	100%

Status of Hardware/Software Development: This is a Level-of-Effort task for management of the KOPIO Detector Construction Project.

Issues (funding, collaborator shortage, engineering help, etc.) All technical positions are onboard and involved. Space and other charges at BNL are uncertain, because this is not a DOE project. Space required at BNL not yet identified. Risk is standing-army costs if project schedule slides. A one-year slip should have a contingency of 20%.